LEAN PERSPECTIVES AND KNOWLEDGE MANAGEMENT APPLICATION IN SERVICE DEPARTMENT OF CNC MACHINE TOOL MANUFACTURER

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Abstract:

Today, customers are increasingly interested in the product surrounding services. Recently, there are continuous requirement for more efficient service package with less resources. The service sector will be affected by the deployment of new organizational frameworks and following the trend of Lean approaches in the production. However, the lean service theory and Knowledge Management (KM) method offer a new vision to product service design. This paper mainly focuses on developing a product surrounding service model to make the traditional mechanical SME more competitive, and we will present the application of KM and Lean service theory in PSS by a case study in a SME Company. This paper is supported by Huron-Graffenstaden (a French CNC manufacturer).

Nowadays, a lot of researches have been made on KM, different KM models have been proposed. On the other side, the Lean has been well developed in production, less in service sector. Our investigations indicate that there is a specific lack in terms of researches between these 2 concepts. In this paper, we assume to develop the product surrounding service model by analysing a real life situation of service department in Huron-Graffenstaden and establish the link between the service Mudas, Lean service tools and different KM stages. The objective is to understand the relationships between these two concepts, in order to see we can use them more efficiently together in a traditional SME.

This article begins by a state of the art of global research context of the project. By analysing the real industrial case, a relationship between Lean service and KM is established. Firstly, we targeted the non-productivity cases in the service department's and link them to the 7 service Mudas. Secondly, we analysis the real and tangible knowledge flows. An analysis of the networks surrounding the department was led thanks to the Actors-Activities-Resources (AAR) model. KM stages faced in the company were also used in this analysis. Then, we make the first link between Lean service and KM by constructing an analysis table with different elements.
From this paper, we can clearly state that there is a relationship between 2 concepts: KM and Lean Service. Both of them could be applied under the Product Service System (PSS) framework and will be helpful for increasing the productivity of a PSS oriented traditional mechanical company. Further study on the relationship between KM and Lean service in PSS is necessary. The indicator for measuring the performance of Lean service and KM performance of a company should be defined

Keywords: Knowledge management, PSS, Lean service, case study, service department

1. Introduction

Since the middle of 20th century, with the wide and profound development of globalization and the increasing severe competition between enterprises, the benefits directly generated by the products is keeping on reducing. Customers are looking forward to one-stop-service solutions which include not only the procurement of products but also the service of installation/set-up, as well as quick responding technical support in case of dysfunction. The concept of product service system (PSS) was emerged in this trend born.

The PSS is a special case of "servitization" which figures to the development of service economy defined by Fuchs as "one in which more than half of total labour force is employed by the service sector" in 1968. Today, more than 70% labour force is engaged in this sector[1].

For instance, Toyota production system is a successful example[2]. The Lean philosophy and its tool box created by Toyota have been widely applied in production sector. In today's economy, the service management becomes more and more important, in order to offer service in a more efficient way but with less resources –doing more with less- which is a principle objective for PSS oriented companies.

As an intersection between production sector and service sector, PSS focus on high-level performance. At the same time, it is been proven that the application of Lean philosophy and its toolbox could improve the performance of production sector[3].

Furthermore, the knowledge economy is considered as a key source of competitiveness. For example, Nonaka has defined a successful company as a knowledge creating company which can constantly create and disseminate knowledge in an organization [4]. The knowledge is defined as "a fluid mixture of framed experience, values, contextual information and expert insight that provides a framework for evaluating and incorporating new experiences and information" [5]. In today's world, where data are omnipresent companies are eager to know how to identify, collect, share and use a huge quantity of knowledge and manage these knowledge flows in a most efficient way.

1.1 Introduction of the case study

Following a top down mixed with a bottom up research approach based on a crossed path of case study[6] and grounded theory, we undertake observations and data collection from real industrial environments while our research is high-lightening by a scientific literature review. Our observations and analysis are also completed by certain qualitative data from industrial projects led by our industrial partner, in line with the grounded theory [7]. Hence, we present the example of Huron CNC tooling machines manufacturer. This company is confronting the exigency of customer on the mechanical performance of products such as accuracy, reliability, speed and higher automatic level. Since recent years, the cumulative experience has been served to offer machining solutions, such as fixation and transmission based on innovation and customization. The latter is a key element of the technical and commercial success for the enterprise. As a SME (small-middle size enterprise), the company has a fairly extensive customization of its various models (60 models offered in catalogue), resulting in a final series of almost unique products for each kind of customer. Furthermore, in Huron's worldwide network, the deployment /setting up/training/after sales service are becoming a key sector of added value creation. The essential objective of the service is to offer the most optimized utilization of tooling machine. In a global economy, companies must adapt to the customers' cultural context, and take account the local factors in order to offer a high level service. Knowledge management may be used to build a more efficient decision-support tool, to better organize

individuals' experiences and competences. The global objective underlying these perspectives is to improve workflows in the service department in more efficient way under Lean service concept and integrating the service department into the continued improvement strategy of the whole company. Different research deadlocks related to this objective are described below.

1.2 Research deadlocks

The scientific question related to the improvement focuses on the issue of implementing a methodology for deploying and capitalizing on good practices when deploying / installing / training / service of CNC tooling machine manufacturer in an international context.

The originality of this work lies in the joint implementation of Lean Management and Knowledge management in an inter-cultural industrial context. Even if it is not to prove that the KM is a key element of management [8], its integration into a continuous improvement process "Lean" applied to intangible process may however raise questions (and sometimes even can be seen as an antagonist approach), taking particular account of the quantization value added of knowledge capitalization process. Moreover, few research works are interested in investigating existing synergies between these two concepts.

Both approaches (KM and Lean) revolve around building a formalized strategy and exploitation of the company's knowledge supported from Lean approach (dashboards with process-oriented indicators). The Lean approach allows structuring the implementation and deployment of a KM approach associated with a decision support system that to formalize and streamline the Lean approach in the audit process and benchmark of performed actions. But on the other hand, the KM may be a key factor in the success of the implementation of Lean, in particular with regard to the practice of the verification phase implemented. In this context, KM, associated with a decision support system, will streamline the audit process through an equity benchmark, and synergy between Lean and KM will be more efficient.

A first scientific deadlock associated is therefore to define a basic knowledge model adapted to the targeted industry. This database will update, enhance, preserve and manage critical knowledge to form a real corporate memory. Meanwhile, the aspect of transmission of knowledge / training / evaluation skills of employees participating in the identified service process will be discussed. A second scientific deadlock consists in the specification of the decision support system, taking into account the high stresses associated with the study; namely context of extended enterprise (preserving the core business expertise the company) and a intercultural context (habits and customs between the different industrial payer and client). A third scientific deadlock will focus on the definition of local or global indicators for characterizing a process from a performance view and to define the expected objectives of excellence in relation to the experience feedback on actions previously undertaken; in the context according to these constraints and previous method. In this article, we will be mainly focused on the first research deadlock. But in order to build an adequate database, relationship between Lean service and KM concepts must be identified and analyzed.

2. Lean and KM in PSS

Today, modern corporations are offering fuller market packages or 'bundles' of customer-focused combinations of goods, services, support, self-service, and knowledge. Therefore, the service-orientation is beginning to dominate products-orientation [9], this trend of revolution is named as "Servitization". As one typical case of the "servitization", PSS (Product Service System) was established in 1999 by Goedkoop who defines the PSS as a

marketable set of products and services that are capable of jointly fulfilling customers' needs in an economical and sustainable manner [10]. In the PSS, a manufacturing company sets its market proposition on extending the traditional functionality of its products by incorporating additional services for reaching new market competitive advantages [11]. In 2010, the term IPSS, also noted as IPS² (Industrial Product-Service System), is characterized by the integrated and mutually determined planning, development, provision and use of product and service shares including its immanent software components in Business-to-Business applications and represents a knowledge-intensive socio-technical system[12]. We can also find some other relative concepts such as Service-Dominant Logic (Service-dominant logic: the service is provided in interaction with customers, but more controversially, that goods purchased and used by customers become a delivery mechanism for service[13]), and Functional Sale (within functional sales, the function-providing company decides how to fulfil the function that the customer is buying[14]).

At the same time, we can find the use of Knowledge management (KM) in the same domain and similar trends can be identified. The knowledge management focuses on the organizational level of the collection and transfer of knowledge from one individual to another in order to make the knowledge usable and available to create value. In this paper, we will focus on how to apply and develop the knowledge management in a SME. We will be more particularly interested in applying this concept in a SME’s service department.

One of the main objectives of lean manufacturing is the identification and elimination of non-value added activities, known as “wastes” or by the Japanese term “Muda”, in production processes, The seven Lean wastes defined by Taiichi Ohno are commonly known as overproduction, defects, unnecessary motion, unnecessary inventory, inappropriate processing, transportation and waiting[15]. Bicheno and Holweg has firstly identified 7 types of service waste in 2009[16]: The Delay, Duplication, Unnecessary Movement, Unclear communication, An opportunity lost to retain or win customers, Errors in the service transaction. These Mudas are based on 7 production Mudas but adapted to service sectors characteristics, the Muda related to customers’ satisfaction is taken in consideration.

In the service sector, the knowledge used by different individuals build the knowledge flow, which is similar to the material flow in production. The existing knowledge models show us different knowledge circles. Every model tries to model the knowledge flow. By this way we can use the Lean tools to improve the knowledge flow The service Muda has some similarity with the production Muda such as deleting unnecessary movement, incorrect inventory and delay. But Muda service is more related to human factors such as: deleting unclear communication, errors in the service transaction and an opportunity lost to retain or win costumer. In the paper, the knowledge management has been defined by different functions as knowledge creation, knowledge building, knowledge transfer and knowledge application which form a knowledge circle.

3. Case study

3.1. Presentation of Huron

Huron-Graffenstaden is a tooling machine manufacturer since 1857 in Alsace France. The company has 154 collaborators. Huron tooling machine are known by theirs accuracy, rigidity, speed. Huron has now 19 product series more than 50 types of different tooling from turning center to 5 axis milling center, from the machine of 1 meter to the machine of 9 meters. The Huron machines has employed in different industrial sector: mold,

automobile, locomotive, aeronautics and medical. About 150 machines are sold every year, 60% of sale is made aboard. 25% turnover is contributed by service department.
Huron has constructed a worldwide network in order to serve the industry. This worldwide network is constituted by two items: Huron's subsidiaries and Huron's agencies. Huron subsidiaries only sell the Huron machine and insure the after-sale service contrary to the agencies, most of whom commercialize not only Huron machine but also the other brands (Agency in China commercialize only Huron machines). In this paper we will focus on the relationship and knowledge transfer between Huron and the agencies.

Huron service department includes a calling center (Hotline), a spare parts center and training center. The mains mission of calling center is to provide technical support and information to end users and field technicians. The spare parts center sell the spare parts and offers technical information on spare parts for old Huron machines (machines from year 60s). The training center makes and supply training program to the end user and to agents. The service department is managed by two managers: an administrative manager and a technical manager in order to answer the specific question in the tooling machine sector. The calling center is constituted by 6 hotline technicians and 1 installation technician. The Spare parts center is constituted by 3 sellers and 1 logistic supporting person. The training center is insured by 2 training engineers.

In order to analyses the relationship between service department and others actors, the AAR (Actors-Activities-Resources) model was used. AAR model is based on the fact that Business relationships are complex. This requires relationships to be considered within the network in which they are embedded. Granovetter (1985) suggests that the structure (or "networks") of these social relations plays a crucial role in generating trust and

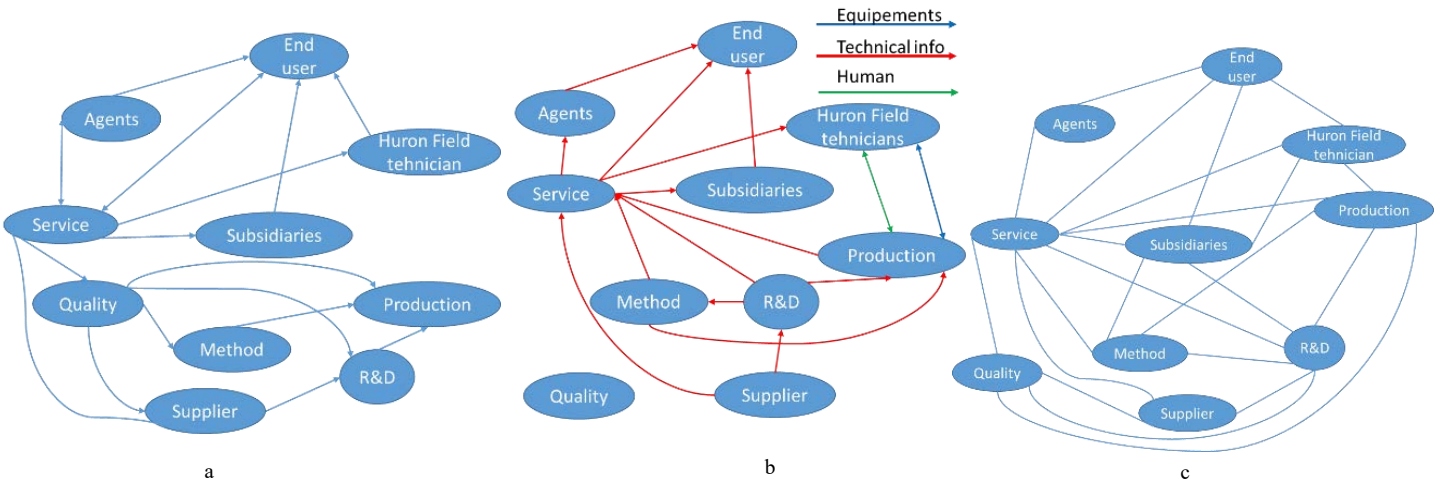

Figure 1 : AAR analyse network

discouraging malfeasance.

The diagram (a) of figure 1 is actors bonds, the line represents the relationship between each actors. We can see that the service department, as a bridge between internal Huron and external, has the most lines. This means that it has relationship with all the others. On the other hand, every Huron internal service has less in relationships with the others. Comparing to the actors network (diagram b of figure 1), the activity network is less intensive than the actors bonds. We can easily find that external actors and internal actors have each other an independent sub activity circle. The service department is the only point which link the two circles. In the diagram c of figure 1, 3 kinds of resources are represented in this network: human, equipment and information. The connectivity of this network is the less intensive. The resource the most shared is technical information. The two other resource

are just shared between production and technicians from the field. This is due to the quality of available people and equipment. We can also find that the technical information is the most important resource.
From the analysis of these three diagrams, we found that the resource ties are less intensive. This which does not match the initial AAR model [17]. We can explain this gap by the following points: the knowledge which refers to the technical information is the most important resource. Secondly, as the end-users have more than one information source which make easier to get machine technical support; thirdly, a lot of information targeted toward the service department shows the importance of knowledge for the department and the difficulty for managing so many knowledge sources and exploiting this knowledge. The last comment that can be done lays on the fact that the quality department is completely out of the resource ties. This means that the quality department does not need a lot technical information and can be a potential source of problems.

3.2 Service department analysis

If we focus only on the service department, we can resume three main activities of service department: Technical support by phone, establishing quotation for field service, preparing and following field service. We want to demonstrate that the lean tools proposed in figure 1 could be used to reduce the 7 types of service Mudas by analyzing these 3 main activities of Huron service department. Then we try to link these real examples to different KM steps and on the same time to link the Lean tools to KM steps. With this strategy, the table in appendix A has been built. We can find the real situations met in Huron service department's everyday life. These are divided in different groups according to the 7 service Mudas and KM steps. The frequency of each situation is given. The potential lean tools are also proposed in order to reduce or get rid of these Muda.

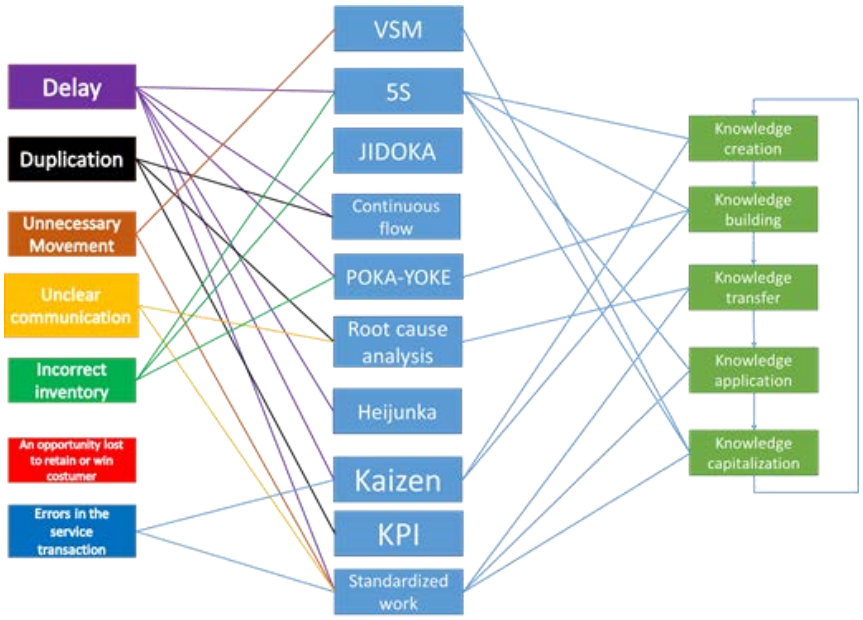

Figure 2: Service Mudas-Lean tools- KM steps links

Nowadays, lots of Lean tools for production have been developed. Our objective was to adapt the existing Lean production tools to Lean service. As an example, HEIJUNKA is used for smoothing the production, but in real life situation like the one encountered at Huron, we can try to use this tool for smoothing the more complex field service (retrofitting the machine, very special part exchanging) which need a lot of technicians resource and immobilize some special tools for a long period. But on the customer side, if these works are not done immediately, they can always continue their productions. By using the HEIJUNKA, we could decompose the global field service to some sub-operations and immobilize just the necessary resources for the defined period

and make the resource available as quick as possible. Another example, JIDOKA is known as autonomation: autonomy and automatic, but in the example of Huron service, in order to avoid the duplication of the quotation, we try to make the establishment of the quotation automatic or the customer can establish their self the quotation(autonomy).

As in figure 2, during a technical support by phone, Hotline technician should be able to get all types of machine technical information (electric drawing, hydraulic drawing, mechanic drawing etc.) as quick as possible. The time to get the useful information can be considered as non-valuable waiting time. The Service Muda --- Unnecessary movement (the number of movement in order to open the right technical information on the server) influence directly on this time. The result of technical support leads to another service Muda --- An opportunity lost to retain or win a customer, since the customer want, if possible, to solve the problem by phone which is cheaper and quicker than a field service. The activities of this phase can be considered as a typical example of "knowledge application" and Knowledge building" cycle (Experience enriched by solving problem and archiving the solution). We can find that by using the Lean tools to reduce the related service Muda let us increase the efficiency of these 2 Knowledge management steps. During a technical support by phone operation, a third Muda exists, unclear communication. During the quotation establishing phase, we can also find the unnecessary movement Muda due to the collection of information. Normally we need to communicate the customer the availability of the spare parts, an incorrect inventory could make a wrong communication to the customers and make them dissatisfied. During field service phase, from a KM point of view, the field service phase contents the Knowledge transfer step which is the one between hotline technician and field technician or between field technicians.

In order to analysis the service department with more details to define key performance indicators (KPI), a Value stream mapping (VSM) has been established. The VSM is a tool that is extensively used in Lean production.

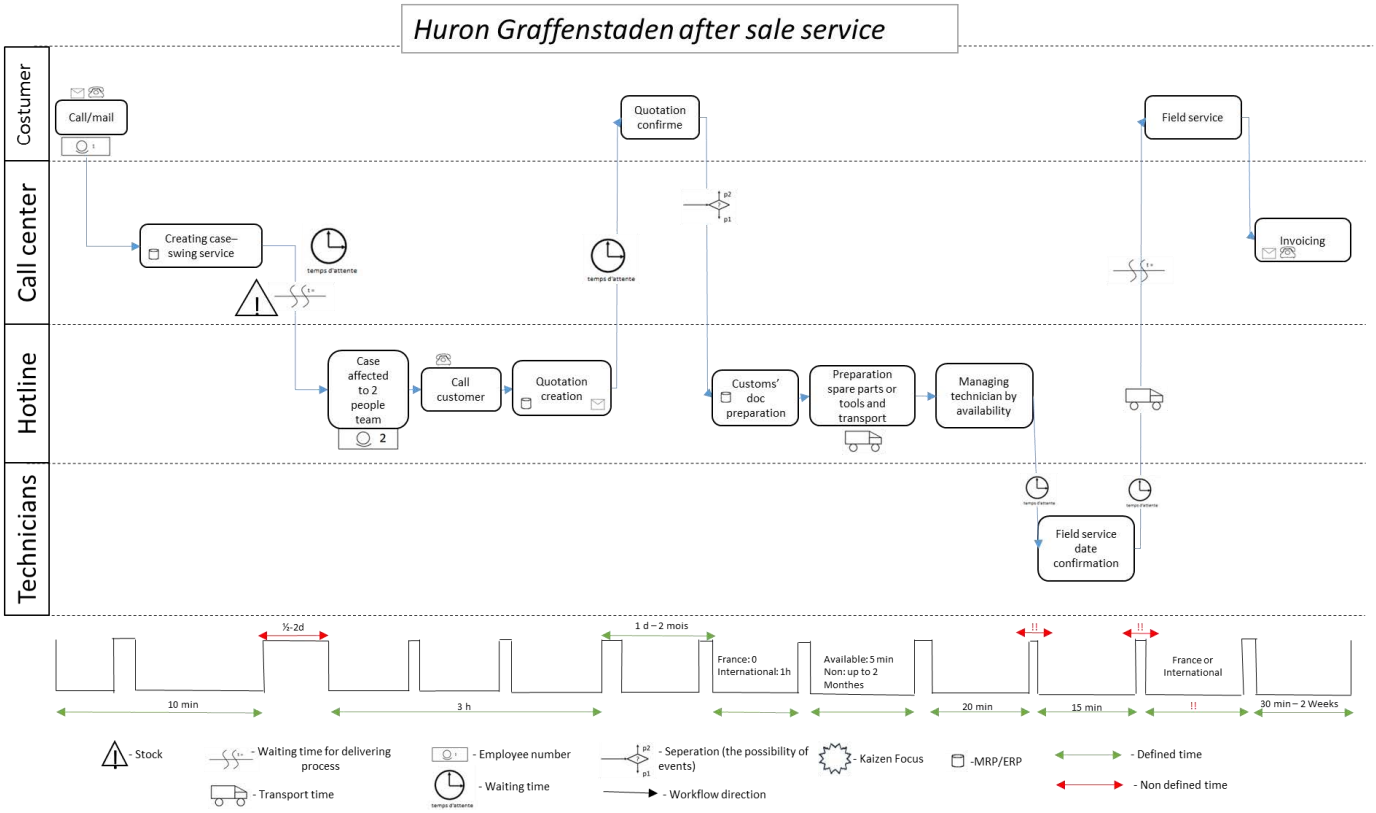

Figure 3: Service VSM of Huron service department

This VSM represents a whole after sales service circle beginning with a customer's reclamation by phone or by email, and ends by the invoice to the end-user of the machine. The most important steps of an after sale service

are mentioned: creation of a case, on line analysis with customer, quotation establishment, preparing for field service, field service and invoicing. The waiting time and the action time is defined according to the experience of the hotline technicians. The improving points have been proposed according to the Lean principles.

By doing this service VSM analysis, we found that a service VSM could be established as a VSM tool adapted from production. The difficulty is that in service VSM duration of each action is much more difficult to quantify, the appearance of the waiting time is the key point for quantifying the whole process. Due to the emergency context, the human factors have more important influences in service VSM than the normal VSM. In a service VSM, a single action could be seen as an interaction between one or more parties, each party could influence the action.

Between the different steps on this VSM, we retrieve the different Knowledge activities as we summarized in the figure 1 and in appendix A. Creation of a case is an activity between the end-user and Huron's call center. The data is transferred from end-user to Huron which can be considered as an initial step of knowledge creation. From a Lean service point of view, if some standardized questions are in place, we can insure the quality and efficiency of data transformation. On line analysis with customer is a knowledge application step, in which the hotline technician should use their experience, their competence, their knowledge of the machine to analysis and make the decision for solving machines' anomalies and plan the next actions. On the other hand, in case of complex situations, obtaining a higher level knowledge or experience from an intern expert is necessary, which is a typical knowledge transfer activity. On the LEAN point of view, an expert map or the 5S for documentation could reduce amount of time for obtaining the useful knowledge. Once the problem is solved, technician will more or less, formally or informally summarize the situation in case for a similar breakdown that can occur in the future. We can consider this as a knowledge capitalization activity. From a Lean point of view, a feedback loop through a root cause analysis could be launched with the R&D or production service in order to improve the quality of the products.

4. Conclusions

This article presented a contribution on how to link Lean approach in service department with a Knowledge management perspective. After a review of the state of the art regarding the last trends in the literature for service activities, a model allowing linking Service Muda with lean tools and KM levels was presented. An application of this model to the service department of a CNC manufacturer was proposed. In order to analyze the real and tangible knowledge flows, an analysis of the networks surrounding the department was led thanks to the AAR model. This analysis was then matched with the proposed model. The above case study issues a mixed research approach based both on a study of the literature and on feedback and outputs from industrial experiments and audits. Since we observe contemporary phenomena within a real-life industrial context, we adopt a case study methodology[18]. The research objective of this case study is based both on descriptive and instrumental objectives. Our goal is purely targeted toward theory building mixing configurative framework providing thick description to be used for other studies and plausibility probes in order to check untested theories and hypotheses requiring more intensive testing[19][20].

Various perspectives can be drawn from these works. One of them can be implemented in the automation of the links that can be made from the analysis of the networks and the potential lean Mudas in the services sector, in order to eradicate them. This must be done thanks to ad hoc KPI gathered in a clear dashboard. The development of this dashboard will be the next step of our works. The service VSM is in this perspective a first try and a preparation for KPI definition. In this way, more researches need to be done on this particular point.

Appendix A. Real cases of service Mudas in Huron

Service Muda	Real example	Activity phase	Possible Causes	Frequency	Leann tools	KM
Delay	Non arrival or wrong spare parts	Preparing and follwing field servie	Wrong end user address in system	Middle	POKA YOKE	Not concerned
			Error of transporter	Middle	-	
			Wrong spare parts location info in system	High	KAIZEN	
			Wrong spare parts defined initiallly	High	-	
	Wrong customer adresse communicated to techician	Preparing and follwing field servie	Wrong end user address in system	Middle	KAIZEN	Knowledge building
			Wrong address communicated to Technician	Low	POKA YOKE	
			Address customer difficult to acces(aboard)	Low	-	
	No necessary tools	Preparing and follwing field servie	Necessary tool occuped	High	Heijunka	Not concerned
			Necessary tool kept by last user	Middle	Continuous flow	
			Necessary tool Broken	Low	KAIZEN	
	Forget of giving order to technician	Preparing and follwing field servie	No displayed on the schedule	Low	Standardized work	Not concerned
			Forget to send	Low	JIDOKA	
Duplication	more than one field service realized in order to solve same problem	Preparing and follwing field servie	Wrong or not enough identification of problem	High	Root cause analysis	Knowledge application
			Short of comptence	Low	KPI	
			Short of spare parts	Middle	Continuous flow	
	more than one similar quotation made for the same customer	Establishing quotation	Duplicated request by customer	Middle	JIDOKA, POKA YOKE	Not concerned
Unnecessary movement	Lots of movement in order to get technical information	Technical support by hotline	Technical information bad organized in the server	High	5S	Knowledge application
			Looking for experience or tacit knowledge of experts	High	-	Knowledge building
			Multi info system without interconnection	High	VSM	Knowledge transfer
			Each service organize their own useful information	High	Standardized work,5S	
	Important duration of invoice	Preparing and follwing field servie	Complicate in admistration proces	High	VSM	Not concernd
			Multi gestion system without interconnection	High	Bottleneck analysis	
Unclear communication	Wrong problem or technical description	Technical support by hotline	Customer doesn't have enough technical competence	Middle	Standardized work	Knowledge transfer
			Bad understanding of problem	Low	Root cause analysis	
	Wrong reference of spare parts	Technical support by hotline	Wrong data	High	KAIZEN, 5S	Knowledge creation
Incorrect inventory	Wrong stock quantity	Preparing and follwing field servie	–	High	5S	Not concerned
	Wrong location of spare parts	Preparing and follwing field servie		High	POKA YOKE, JIDOKA	
An opportunity lost to retain or win a customer	Bad alttitude with customer during technical support by phone or in field service	Technical support by hotline	Pressure for solving the problem	High	-	Not concerned
			Bad alttitude of customer	Middle	-	
			Long technical support on phone	Middle	-	
Errors in the service transcation	Tools or goods lost or damaged	Preparing and follwing field servie	Wrong manipulation	Low	Standardized work	Kwonledge application
			Damaged during transport	Low	Kaizen	Not concerned

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